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By

Signature

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Docket No: 154616.1/MCS-051-00
PATENT APPLICATION
USPTO CUSTOMER NUMBER: 27662

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of Yan et al.	Group Art Unit: 2623
Entitled: SYSTEM AND METHOD FOR FACE RECOGNITION USING SYNTHESIZED IMAGES	Examiner: Vikkram, Bali
Serial No.: 09/728,936	
Filing Date: December 1, 2000	

APPEAL BRIEF

Mail Stop Appeal Brief-Patents
Commissioner for Patents
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Alexandria, VA 22313-1450

I. REAL PARTY IN INTEREST

The subject application is assigned to Microsoft Corporation, of Redmond Washington.

II. RELATED APPEALS AND INTERFERENCES

There are no known related appeals or interferences.

III. STATUS OF CLAIMS

Claims 1 through 23 represent all claims currently pending in the application. These claims are provided for reference in the attached Appeal Brief Appendix. The rejection of claims 1-17 is hereby appealed. No reason for the rejection of Claims 18-23 have ever been provided in the prosecution of this case. It is assumed for purposes of this appeal that Claims 18-23 are allowed.

IV. STATUS OF AMENDMENTS

No amendments are currently pending.

V. SUMMARY OF THE INVENTION

In general, the Appellants' claim a system and method that allows for face recognition even in the absence of a significant amount of training data. Further, it can recognize faces at various pose angles without the need to capture training images exhibiting the corresponding pose. This is accomplished by synthesizing training images depicting a subject's face at a variety of poses from a small number of actual images of the subject's face. (Specification, page 2, lines 7-12) The system and process according to the claimed invention employs a generic 3-D graphic face model and the small number of images of the subject's face in an automatic deformation technique to create a single, specific 3-D face model of the subject from the generic model and images. (Specification, page 2, lines 25-30). A subdivision spline surface

construction technique is next used to "smooth" the specific 3-D face model and a multi-direction texture mapping technique is used to endow texture or photometric detail to the face model to create a texturized, smoothed, specific, 3-D face model. This technique adds realism to the synthetic human faces. (Specification, page 3, lines 18-24).

Once a 3-D face model of a specific subject is obtained, realistic individual virtual faces or 2-D face images are synthesized at various poses to create groups of training images for input into a "recognizer" to allow for training of the recognizer. It is also optionally possible to take the generated images and synthetically vary the illumination to produce each image at various illuminations. In this way, subjects can be recognized regardless of the illumination characteristics associated with an input image. (Specification, page 4, lines 9-17).

VI. ISSUES

In the final Office Action dated March 5, 2004, claims 1-11 and 16 were rejected under 35 USC 103(a) as being unpatentable over Yan et al's publication, in view of Kung, U.S. Patent No. 5,850,470. Claims 12-15 were rejected under 35 USC 103(a) as unpatentable over Yan, in view of Kung, and in further view of Deering, U.S. Patent No. 6,525,723, hereinafter Deering. Claim 17 was rejected under 35 USC 103(a) as unpatentable over Yan, in view of Kung and in further view of Georghiades, June 1999. The Appellants respectfully disagree with this contention of obviousness.

VII. GROUPING OF CLAIMS

1. Claims 1-11 and 16 stand or fall together.
2. Claims 12-15 stand or fall together
3. Claim 17 stands or falls alone.

VIII. THE EXAMINER'S RATIONALE

The Examiner's rationale for the rejection of independent claim 1 under 35 U.S.C. §103 as being obvious by Yan et al's publication, in view of Kung, U.S. Patent No. 5,850,470 was stated in the Final Office Action of January 12, 2004 and maintained in the Advisory Action to the Appellants after final Response is as follows:

> "I. Applicant argues that reference Yan fails to disclose the following features:....b) training of a 3D face recognizer, (page 12, paragraph 2)....With regards to the limitation b) the limitation is taught by the teaching reference Kung, see col. 4, lines 5-13, wherein the lines 10-11 specifically calls for a face database 16 used to train the face detector. II. Applicant argues that the reference Kung fails to disclose the following features: a) no use of a synthesized database to train a face recognizer (page 13, paragraph 1)... With regard to the limitation a) the limitation is disclose by the primary reference Yan, synthesizing various face pose images, see page 857, col.2, lines 17-32, the images are synthesized and calls for using the manipulating polygonal mesh of human face model and further smoothing the images using the plastic visco elastic behavior of the facial skin i.e. "synthesizing various face pose images."...Arguments regarding Claims 12-15 and 17...Applicant argues that Yan, Kung and Deering fail to disclose a) a training recognition system that recognizes a person based on a single image by employing this image to generate a synthesized database (page 15 and 16 paragraph 2)...The claim 1, claims the limitation of 'various face pose images" i.e. more then one or an image that is disclosed by the reference Yan see figure 6, wherein three poses of a subject is taken and synthesized."

IX. ARGUMENT

A. The 35 U.S.C. §103(e) Rejection of Claims 1-11 and 16:

As explained by the Appellants' in their response filed August 25, 2003, and again in the Appellants' Request for Reconsideration filed November 17, 2003, the Office Action rejected independent claim 1 under 35 U.S.C. §103(e), based on the rationale that Yan discloses a deformable model of a realistic face but does not teach the training of a 3D face recognizer for face recognition. However, the Office Action further contended that Kung teaches a facial recognition system using a database of images to train the recognizer. The Office Action argued that this combination teaches the Appellants invention. The Appellants respectfully disagree with this contention of obviousness.

In order to deem the appellants' claimed invention unpatentable under 35 USC §103, a prima facie showing of obviousness must be made. To make a prima facie showing of obviousness, all of the claimed elements of an appellant's invention must be considered, especially when they are missing from the prior art. If a claimed element is not taught in the prior art and has advantages not appreciated by the prior art, then no prima facie case of obviousness exists. The Federal Circuit court has stated that it was error not to distinguish claims over a combination of prior art references where a material limitation in the claimed system and its purpose was not taught therein (*In Re Fine*, 837 F.2d 107, 5 USPQ2d 1596 (Fed. Cir. 1988)).

The Appellants claim a system and method that allows for face recognition even in the absence of a significant amount of training data. Further, it can recognize faces at various pose angles without the need to capture training images exhibiting the corresponding pose. This is accomplished by synthesizing training images depicting a subject's face at a variety of poses from a small number of actual images of the subject's face. The system and process according to the claimed invention employs a generic 3-D graphic face model and the small number of images of the subject's face in an automatic deformation technique to create a single, specific 3-D face model of the subject from the generic model and images. Once a 3-D face model of a specific

subject is obtained, realistic individual virtual faces or 2-D face images are synthesized at various poses to create groups of training images for input into a "recognizer" to allow for training of the recognizer. It is also optionally possible to take the generated images and synthetically vary the illumination to produce each image at various illuminations. In this way, subjects can be recognized regardless of the illumination characteristics associated with an input image.

In contrast, Yan teaches a human face generation technique using a three-dimensional deformation technique. The deformation technique allows interactive alignment of features in the general geometric face model with the features of the multi-direction images of the specific human face which are pre-provided by the animator. The deformation result provides an approach to generate 2D images simulating the plastic-visco-elastic behavior of the facial skin (page 587, end of second paragraph) and exhibiting a **facial expression.** (page 587, Abstract) Yan requires images in several directions to be input in order to apply the skin texture (page 858, last paragraph). Yan does not synthesize images of different face poses and, as the first Office Action stated, **Yan does not teach the training of a 3D face recognizer for face recognition**. More importantly, the cited **Yan reference does not teach the synthesis of training images exhibiting different face poses of a subject or the training of a 3D face recognizer using synthesized images**.

Although the appellants pointed out this distinction in the last Office Action, the Examiner did not respond to this argument of that **synthesizing pose-varying training images to train a 3D face recognizer** is not taught in this cited reference. Yan simply does not teach this claimed feature of using **synthesizing various face pose images using the specific 3-D face model; and employing the synthesized images as training images to train a recognizer**. Rather Yan teaches creating a specific face model for generating images of a subject that exhibit different facial expressions (abstract, page 857, page 859, last paragraph), not face poses. It is noted that a face pose is a term of art meaning the pitch, roll and yaw angles defining the direction a face is pointed usually in relation to a full frontal view.

Granted, the Examiner states that Yan teaches this feature at page 857, col. 2, lines 6-32 which state,

> "This paper aims at the following two aspects...1. Based on the multi-direction images pre-provided by the animator, we proposed a general method for manipulating polygonal mesh of human face model, which deform the current face model to get a new face model by specifying the new 3-D positions of a set of specific vertexes (feature points). When move a vertex to match the specific feature point in the image, the deformation algorithm automatically calculate the new position of the relative vertex around the moved vertex. **This simulate the plastic-visco-elastic behavior of the facial skin**. 2. Multi-direction texture mapping technique is developed to further enhance the realism of the synthesized human face. We designed an algorithm to select texture information from the frontal view and profile view images of the specific subject's face."

However, this cited passage is just an overview of Yan's process of generating different facial expressions by moving vertices of a face model. **No mention is made in this passage, or the rest of the Yan reference, <u>of generating a set of synthesized images to train a recognizer</u>.**

The application of Kung does nothing to change the fact that the cited art combination lacks the claimed synthesizing and training features of the appellants' claimed invention. Kung discloses a system for automatically detecting and recognizing the identity of a deformable object such as a human face, within an arbitrary image scene. The system comprises an object detector implemented as a probabilistic DBNN, for determining whether the object is within the arbitrary image scene and a feature localizer also implemented as a probabilistic DBNN, for determining the position of an identifying feature on the object such as the eyes. A

feature extractor is coupled to the feature localizer and receives coordinates sent from the feature localizer which are indicative of the position of the identifying feature and also extracts from the coordinates information relating to other features of the object such as the eyebrows and nose, which are used to create a low resolution image of the object. A probabilistic DBNN based object recognizer for determining the identity of the object receives the low resolution image of the object inputted from the feature extractor to identify the object. The system 10 comprises a video camera 12 for inputting an arbitrary image scene 11 with 320 by 240 pixels. A DBNN-based face detector 14 is coupled to the video camera 12 and includes a memory 16 which operates as a database for storing images of different human faces. The face detector 14 determines whether a face is within the arbitrary image scene 11. The data stored in the face database 16 is used to train the face detector 14. During training, updated network weighting parameters and thresholds are stored in the face database 16. **However, Kung does not teach synthesizing images of different face poses from a specific model of a subject and using these synthesized images to create the aforementioned database. Rather, Kung teaches extracting a large number of training images from videos of a subject.**

Thus, the appellants have claimed elements not taught in the cited art and which have advantages not recognized therein, namely the ability to **synthesize images of different face poses from a specific model of a subject from just a few actual pictures of the subject and using these synthesized images to train a recognizer**. Accordingly, no prima facie case of obviousness has been established in accordance with the holding of *In Re Fine*. This lack of prima facie showing of obviousness means that the rejected claims are patentable under 35 USC 103 over Yan in view of Kung as evidenced by the non-obvious claim language of Claim 1:

> " A computer-implemented process for face recognition, comprising using a computer to perform the following process actions...inputting an image of a face of a subject sought to be recognized having a particular face pose; inputting a generic three dimensional face

model; creating a specific three dimensional face model of the specific subject sought to be recognized by deforming the generic face model to conform to the shape of the face depicted in the input image; **synthesizing various face pose images using the specific 3-D face model; and employing the synthesized images as training images to train a recognizer**. " (emphasis added)

B. The 35 U.S.C. §103(e) Rejection of Claims 12-15:

Claims 12-15 were rejected under 35 USC 103(a) as unpatentable over Yan, in view of Kung, and in further view of Deering, U.S. Patent No. 6,525,723, hereinafter Deering. The Examiner stated that Yan and Kung do not teach assigning the color intensity of each pixel in order to perform textural analysis. However, the Examiner contended that Deering teaches this feature. The Examiner further contended it would have been obvious to have modified the Yan and Kung systems by Deering's color intensity calculations. The appellants respectfully traverse this contention of obviousness.

The Appellants' claimed invention allows for face recognition even in the absence of a significant amount of training data. Further, it can recognize faces at various pose angles even without actual training images exhibiting the corresponding pose. This is accomplished by synthesizing training images depicting a subject's face at a variety of poses from a small number of actual images of the subject's face and using these synthesized images to train a recognizer.

Neither Yan, Kung, nor Deering disclose a system and method that allows the training of a recognition system by employing at least one image to generate a synthesized training database. Nor does Yan in combination with Kung and Deering recognize the advantages of the appellants' claimed invention. Namely, neither Yan, Kung, nor Deering, alone or in combination, teach the appellants' claimed system and method of face recognition using a training database made of synthesized images.

Thus, the appellants have claimed elements not taught in the cited art and which have advantages not recognized therein. Accordingly, no prima facie case of obviousness has been established in accordance with the holding of *In Re Fine*. This lack of prima facie showing of obviousness means that the rejected claims are patentable under 35 USC 103 over Yan in combination with Kung and Deering.

C. **The 35 U.S.C. §103(e) Rejection of Claim 17:**

Claim 17 was rejected under 35 USC 103(a) as unpatentable over Yan, in view of Kung and in further view of Georghiades, June 1999. The Examiner stated that Yan and Kung do not teach varying illumination to produce synthesized images. However, the Examiner contended that Georghiades teaches this feature. The Examiner further contended it would have been obvious to have modified the Yan and Kung systems by Georghiades' teachings. The appellants respectfully traverse this contention of obviousness.

As discussed previously, the appellants' claimed invention allows for face recognition even in the absence of a significant amount of training data. Further, it can recognize faces at various pose angles even without actual training images exhibiting the corresponding pose. This is accomplished by synthesizing training images depicting a subject's face at a variety of poses from a small number of actual images of the subject's face. These synthesized images are used to train a recognizer.

Georghiades teaches an illumination-based method for synthesizing images that does not require any knowledge of light source directions or the establishment of point or line correspondences. However, like Yan and Kung, **Georghiades does not disclose a system and method that allows the training of a recognition system to recognize a person based on a synthesized database.**

Therefore, **Yan, Kung, nor Georghiades, alone or in combination, do not disclose a system and method that allows the training of a recognition system to**

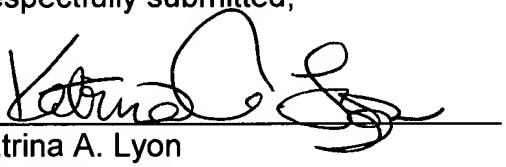
recognize a person based on a synthesized database. Nor does Yan in combination with Kung and Georghiades recognize the advantages of the appellants' claimed invention. Namely, neither Yan, Kung, nor Georghiades, alone or in combination, teach the appellants' claimed system and method of face recognition using a training database made of synthesized images generated from as little as one image.

Thus, the appellants have claimed elements not taught in the cited art and which have advantages not recognized therein. Accordingly, no prima facie case of obviousness has been established in accordance with the holding of *In Re Fine*. This lack of prima facie showing of obviousness means that the rejected claim is patentable under 35 USC 103 over Yan in combination with Kung and Georghiades.

X. SUMMARY

For the foregoing reasons, it is respectfully submitted that the Examiner's rejection of Claims 1-17 was erroneous. As such, reversal of the Examiner's decision is respectfully requested at the earliest opportunity.

Respectfully submitted,



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Filing Date: December 1, 2000	:	

APPEAL BRIEF APPENDIX

The following Claims 1-23 represent all the claims involved in the appeal of the above-identified application and are provided in accordance with the requirements of 37 CFR 1.192:

CLAIMS

1. (Original) A computer-implemented process for face recognition, comprising using a computer to perform the following process actions:

inputting an image of a face of a subject sought to be recognized having a particular face pose;

inputting a generic three dimensional face model;

creating a specific three dimensional face model of the specific subject sought to be recognized by deforming the generic face model to conform to the shape of the face depicted in the input image;

synthesizing various face pose images using the specific 3-D face model; and

employing the synthesized images as training images to train a recognizer.

2. (Orginal) The computer-implemented process of Claim 1 further comprising the process action of using a spline surface construction technique to smooth the specific face model.

3. (Original) The computer-implemented process of Claim 2 further comprising the process action of using a texture mapping technique to endow textural detail to the smoothed face model.

4. (Original) The computer-implemented process of Claim 1 wherein the process action for inputting an image of a face comprises inputting one frontal view and one profile view of the face.

5. (Original) The computer-implemented process of Claim 1 wherein the process action for inputting an image comprises inputting at least two views of a face each having poses varying in orientation from the others by at least 15 degrees.

6. (Original) The computer-implemented process of Claim 1 wherein the process action for inputting a generic three dimensional face model comprises employing a polygon model that depicts the surfaces of the face as a series of vertices defining a facial mesh.

7. (Original) The computer-implemented process of Claim 6 wherein the process action for creating a specific three dimensional face model of the subject comprising using a deformation technique to create a specific three dimensional model of the subject from the generic model and the input images.

8. (Original) The computer-implemented process of Claim 7 wherein the process action of using a deformation technique to create a specific three dimensional model further comprises the process actions of:

extracting feature point sets from input frontal and profile images of the subject; and

modifying the generic face model to the specific face model by comparison and mapping between the feature point sets.

9. (Original) The computer-implemented process of Claim 4 wherein symmetry of the face is assumed, such that for the purposes of said creating of a specific 3-D face model it is assumed the side of the face opposite that depicted in the profile image has the same shape and coloring.

10. (Original) The computer-implemented process of Claim 1 wherein two or more images are used to create the model of a specific face, further comprising a process action of refining the specific model of the face by using additional images.

11. (Previously Presented) The computer-implemented process of Claim 2 wherein a facet-based representation of the specific face is replaced with a spline surface representation.

12. (Original) The computer-implemented process of Claim 3 wherein the process action to endow textural detail to the face model further comprises the process action of using the input images to assign color intensity to each pixel of the three dimensional face model.

13. (Original) The computer-implemented process of Claim 12 wherein a Bézier patch technique is employed to add texture detail to a face model.

14. (Original) The computer-implemented process of Claim 13 wherein the process action for assigning color intensity further comprises the process action of:

for each Bézier surface patch of the face surface determining a corresponding texture patch by mapping the boundary curve of the Bézier patch to the face image.

15. (Original) The computer-implemented process of Claim 13 wherein both frontal and profile images are employed and wherein the face image chosen to provide the texture information depends on the preferred direction of the Bézier patch; such that the frontal image is used to map when the angle between the direction and the Y-Z plane is less than 30 degrees and wherein a profile image is used when the angle between the direction and the Y-Z plane is greater than 30 degrees.

16. (Original) The computer-implemented process of Claim 1 wherein face pose images are synthesized for every in-plane rotation of plus or minus 10 to 15 degrees and every out-of-plane rotation of plus or minus 15-20 degrees, with increments of about 3-7 degrees within a group.

17. (Previously presented) The computer-implemented process of Claim 1 wherein illumination is varied to produce the synthetic images at varied illuminations by taking the generated images and synthetically varying the illumination to produce each image at various illuminations.

18. (Original) A system for generating synthesized face images, the system comprising:

at least one camera positioned so capture at least one image of a subject for whom images are to be synthesized;

a general purpose computing device; and

a computer program comprising program modules executable by the computing device, wherein the computing device is directed by the program modules of the computer program to,

input at least one image of a face of a subject from the at least one camera;

input a generic face model;

create a specific face model of the subject by deforming the generic face model to conform to the shape of the face depicted in the input image; and

synthesize various face poses using the specific 3-D face model.

19. (Original) The system of Claim 18, further comprising a computer module to,

employ the synthesized images as training images by inputting the synthesized images into a recognizer.

21. (Original) The system of Claim 18, further comprising a computer module to,

use a spline surface technique to smooth the specific face model.

22. (Original) The system of Claim 21, further comprising a computer

module to,

use a texture mapping technique to endow textural detail to the smoothed face model.

23. (Original) A computer-readable medium having computer-executable instructions for generating synthesized images of a face, said computer-executable instructions comprising:

inputting an image of a face of a subject having a practicular face pose;

inputting a generic three dimensional face model;

creating a specific three dimensional face model of the specific subject by deforming the generic face model to conform to the shape of the face depicted in the input image;

using a spline surface construction technique to smooth the specific face model;

using a texture mapping technique to endow textural detail to the smoothed face model;

synthesizing various face pose images using the specific 3-D face model; and

employing the synthesized images as training images to train a recognizer.

Respectfully submitted,

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